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EFFICACY OF SPEECH THERAPY WITH EDUCABLE MENTALLY RETARDED CHILDREN.

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A TWO-PHASE PROJECT CONCERNED WITH THE EFFECTIVENESS OF SPEECH THERAPY WITH EDUCABLE MENTALLY RETARDED (EMR) CHILDREN IN A PUBLIC SCHOOL SETTING HAD TWO OBJECTIVES--TO ASSEMBLE A REASONABLY COMPLETE PICTURE OF ARTICULATION OF EDUCABLE MENTALLY RETARDED CHILDREN AND TO DETERMINE THE VALUE OF SPEECH THERAPY TO EMR CHILDREN WITH ARTICULATION DEFICIENCIES. THE HEJNA ARTICULATION TESTS AND A SPEECH INTELLIGIBILITY RATING OF 777 CHILDREN (AGES 6-16, IQ RANGE 48-78) WERE ANALYZED, AND THE 415 SPEECH HANDICAPPED WERE DIVIDED INTO THREE GROUPS--(1) EXPERIMENTAL, GIVEN SPEECH THERAPY TWICE WEEKLY, (2) CONTROL, GIVEN NO THERAPY, (3) PLACEBO, GIVEN GENERAL LANGUAGE STIMULATION, WITH NO SPECIFIC WORK ON ARTICULATION SOUNDS. EVALUATION OF PROGRESS WAS BASED ON ARTICULATION TESTS GIVEN AT SIX-MONTH INTERVALS OVER A THREE-YEAR PERIOD. STUDY OF SUBJECTS BEFORE THERAPY SHOWED SEVERITY OF ARTICULATION ERRORS WAS NOT SIGNIFICANT TO IQ AT THE .01 LEVEL, BUT CHRONOLOGICAL AGE (CA) AND MENTAL AGE (MA) HAS A SIGNIFICANT RELATIONSHIP TO SEVERITY. MEDIAN TESTS REVEALED THAT DIFFERENCES SIGNIFICANT AT THE .01 LEVEL EXISTED BETWEEN THE SPEECH HANDICAPPED AND THE NON SPEECH HANDICAPPED IN REGARD TO IQ, MA, AND CA. THE HYPOTHESIS THAT THE DEVELOPMENT OF SPEECH BY MA LEVELS OF THE RETARDATES COULD CLOSELY ALIGN WITH THE DEVELOPMENT OF SOUNDS BY CA OF NORMAL CHILDREN WAS REJECTED. THE HYPOTHESIS THAT THE SEVERITY OF ARTICULATION HANDICAPS IS A FUNCTION OF MA AND CA WAS ACCEPTED. DIFFERENCES BETWEEN THE EXPERIMENTAL GROUP AND THE CONTROL OF PLACEBO GROUP WERE NOT STATISTICALLY SIGNIFICANT. SPEECH THERAPY WAS FOUND TO HAVE NO MORE SIGNIFICANT EFFECT ON SOUND ERROR REDUCTION THAN DID MATURATION. DATA ABOUT THE RELATIONSHIP OF SEX TO ERROR REDUCTION WAS NOT FOUND SIGNIFICANT. TABLES PRESENT STATISTICAL FINDINGS. A 21-ITEM REFERENCE LIST IS INCLUDED. (JB)

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EFFICACY OF SPEECH THERAPY WITH EDUCABLE MENTALLY RETARDED CHILDREN

COOPERATIVE RESEARCH PROJECT NO. 1607

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SPECIAL DISTRICT FOR THE EDUCATION AND TRAINING OF HANDICAPPED CHILDREN OF ST. LOUIS COUNTY, MISSOURI

1962 - 1965

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PROBLEM

Interest in the communicative behavior of mentally subnormal children has grown more intensive as diagnostic and educational procedures for mental retardates have expanded. Investigators who deal with the mentally retarded have defined several areas of deficiency in the speech and language ability exhibited by these children. Previous studies have indicated that there is a broad extent of articulatory deviations in both institutional and public school populations. A summary of the incidence of speech disorders in mentally retarded children has been provided by Matthews (19) who reported results from approximately fifteen studies completed between 1930-1953. In these studies, largely concerned with institutionalized children, the percentages of incidence stated were greatly varied. In the recent Parson's Project concerning language and communicative skills of retarded children, Schiefelbusch (14) refers to a survey of speech deficits by Spradlin:

1. From 57 to 72 percent of institutionalized mental defectives have speech defects.

2. Approximately 72 to 82 percent of severely retarded children in parent sponsored day schools have speech defects.

3. Eight to 26 percent of the children in special classes of the public schools have speech defects.

4. Articulation and voice problems comprise the largest percentage of speech problems among mentally retarded children.

Although incidence findings of previous studies and the present research establish basic information about the speech of the retarded child, further investigation of the articulatory functioning of retardates should provide a more definitive appraisal of the many

facets of articulation deviation. Types of articulatory errors have been studied by several investigators: Russell (4) reported a comparative study of errors exhibited by retarded and normally intelligent children in terms of substitutions, omissions and indistinct categories. Bangs (2) states that the speech errors of the retarded are about the same as those of normal children with the exception of the area of omissions. Karlin and Strazulla (6) have listed the specific sounds on which retarded children most often err. The results reported have involved a rather isolated area of articulatory functioning and do not present a universal description of the speech deviations of mentally retarded children.

The research reported here represents a two-phase project concerned with the efficacy of speech therapy for the educable mentally retarded child within a public school setting. The sample of 777 children (IQ 48 to 78) was drawn from classes of the Special District for the Education and Training of Handicapped Children of St. Louis County. In brief explanation, the Special District works entirely for the education of those children with visual, orthopedic, auditory, mental or speech handicaps. Much of the program with educable retardates has been carried on within public schools, using personnel of the Special District who are responsible for all facets of training the mildly retarded child. In the initial structuring of the speech and hearing division of the district, three speech clinicians were responsible for evaluating the articulatory ability of educable children in approximately 85 classes.

The clinicians identified the speech defective population and supplied therapy for a limited number of children. Initial speech screening of the entire educable population tended to confirm what previous investigators had reported, that many mildly retarded children have articulatory deviations. Any attempt to provide speech therapy for all the retarded children who exhibited articulation defects would have involved an extensive financial and time consuming program for Special District. The clinicians and director of the speech department were of the opinion that a precise description and analysis of the speech behavior would clarify the development of a comprehensive, yet realistic, approach to effective speech programs for the educable child. Because there has been little previous research concerning speech therapy for large populations of educable children in public schools, two problems confronted the investigators. The first problem was one of gaining an adequate and comprehensive body of information concerning the incidence and characteristics of articulatory deviations manifested by the educable child. The second problem was to determine the merit of providing speech therapy to mildly retarded children with articulation deficiencies.

This research project was initially viewed as a two-phase problem, with Phase I concerning description of articulation behavior in a large population of educable mentally retarded children in a non-institutionalized setting. Several questions evolved from this central descriptive problem; What is the incidence of speech defective children in the total population? Of those children with articulation deviations, what is the severity of the problem according to the

number and consistency of errors and the communicative effect on the listener? What is the nature of the articulatory errors in terms of position in words, type of error, total number of sounds in error, sonat or surd errors, or errors in the phonetic categories such as plosives, fricatives, sibilants, affricates, blends, nasals and glides? Analysis of this information becomes more meaningful as it is related to the factors of intelligence quotient, chronological age, mental age, sex, and socio-economic status. The following questions were used as a guide for the investigation of articulation skills: Is there a relationship between the severity of mental retardation and the incidence and severity of articulation deviations? Are there prevalent types of articulatory problems according to the MA, CA or IQ of the child? Is there a pattern of articulation development that is unique to the educable retarded child? Is there a relationship between the sex or economic status of the child and the number or type of articulation deviations he exhibits?

In Phase II, which involves consideration of the effects of speech therapy administered to the educable child, the following questions were used as guides to the investigation of the problem: Do the retarded children who receive speech therapy on a regular basis differ in rate and extent of progress from those children who receive no therapy or those who receive an indirect type of communication therapy?[1] If improvement of speech results after a three year period

1. In this particular project speech therapy was limited to specific articulation therapy, therapy designed to correct defective sounds. The no-therapy group were considered as controls. The Placebo group was given a non-sound oriented type of therapy.

is there a relationship between the degree of improvement and the MA or IQ of the child, regardless of intensive therapy or lack of it? Is there evidence that a traditional auditory centered approach to therapy is advantageous to the educable child? Does the articulation pattern of the child involved in speech therapy change significantly in incidence of errors, type of errors, or position of error sounds?

The research presented here represents the specific problem of Special District's need to evaluate and plan the most beneficial, but rational, program of speech habilitation to a large number of educable children. From another point of view, the problem is one which confronts the speech clinician in any setting where the mildly retarded child is identified and presented as a possible therapy candidate. The investigation followed here may provide a basis for evaluation of the child's communication ability in comparison to the ability of other educable retardates and the results of speech therapy may serve as a guide to prognosis.

OBJECTIVES

In Phase I, the primary objective was to create a reasonably complete body of information about the articulation of educable mentally retarded children. Several areas of investigation were necessary to establish a cohesive picture of the articulatory behavior of these retardates. The three divisions of necessary information concerned (1) incidence of articulation deviations, (2) types of error which occurred in the speech defective population, and (3) relationship of severity and type of speech deviation to factors such as IQ, MA, and CA.

Concerning the preceding three categories, the objectives of Phase I were as follows:

A. To establish the number of speech defective and non-speech-defective children within a given school age population of educable mentally retarded subjects with IQ 48-78.

B. To define the speech defective population according to sex, race, socio-economic status and other related factors.

C. To define and scale the speech defective population by determining the severity of the problem according to number and consistency of errors and the communicative effect on the listener.

D. To establish the nature of articulatory errors which occur:

(a) by position in words
(b) by type of error substitution, omission or distortion
(c) by sonat or surd grouping
(d) by phonetic categories such as plosive or sibilant
(e) by number of total sounds in error

E. To determine the relationship between degree of retardation and the severity of the speech deviation.

F. To determine if there are prevalent types of articulatory problems according to particular MA, CA, or IQ groups.

G. To establish an articulation developmental pattern for the educable mentally retarded population and to determine if this pattern is unique to the group.

H. To determine whether the severity or type of articulation problem is related to the sex or socio-economic status of the child.

The major objective of Phase II was to determine the efficacy of providing speech therapy to educable mentally retarded children with articulation deficiencies. The investigators made no initial claim for the merit or demerit of working with the educable children, but did feel that a controlled program would establish valuable information. To gain the major objective of Phase II, the following steps were taken:

A. Establish these three groups by random selection of the speech defective population:

(a) Experimental - to be administered speech therapy twice weekly by a qualified speech clinician using articulation therapy.(1)

(b) Control - to be administered no therapy

(c) Placebo - to be administered a general language stimulation program twice weekly with no direct work on articulation skills.

1. Therapy which attempts to correct deviant sound production by direct emphasis on the erred sound, using ear training, phonetic placement, visual and auditory stimulation.

B. Record articulation tests of all children in the groups at six-month intervals. At the end of the three-year program, obtain judgment of the recordings to ascertain this information:

(a) Does a difference exist in the rate or extent of progress of the experimental group as contrasted to control or placebo group?

(b) Is there a significant difference in the speech progress of any of the three groups?

(c) Is there a relationship between the degree of improvement and the IQ, MA or CA of the children in any group?

(d) Is there evidence to determine if articulation therapy as previously defined is advantageous to the educable child?

RELATED RESEARCH

The presence of widespread communication disorders among populations of retarded children has been established by various investigators. Studies have been conducted which define several areas of deficiency in the speech and language abilities of children with lowered limits of intelligence. There appears to be a rather universal agreement that articulatory deviations constitute a major part of the communication problems of the retarded child in both institutional and private or public school settings. As mentioned previously, a summary of the incidence of speech disorders was provided by Matthews (19) who reported results from approximately fifteen studies completed between 1930-1953. These studies were largely concerned with institutionalized children and the percentages of incidence stated from the projects were varied according to the type of population. Studies concerning more specific types of speech deviations tend to concentrate on the articulation aspect of communication. Russell (4) studied 209 mentally retarded school age children in California with IQ's ranging from 40 to 79 and a mean IQ of 65.5. The experimental population was compared with a control group of speech defective non-retarded children. Following is a resume of the results of his comparative study:

PERCENTAGE DISTRIBUTION OF ARTICULATION ERRORS OF MENTALLY RETARDED AND MATCHED GROUPS OF SCHOOL AGE CHILDREN:

Type of Error	Mentally Retarded	Matched Group
Substitutions	51.4	35.9
Omission	12.2	4.4
Indistinct	33.4	59.7

The preceding study indicates that the mentally retarded group showed more errors of substitution while the matched group of normals made more errors in the area of indistinct sounds. Russell also noted four times as many vowel errors in the retarded group as he did in the matched group.

Utilizing a broader grouping, Schlanger states the following about the Vineland Training School subjects: "Specifically 77 percent had articulation defects of varying degrees, 42 percent were voice defectives and 18 percent stuttered." (16) In an additional study of 516 residents of the same school, Schlanger found that 400 subjects, or 78 percent, had articulatory errors ranging from slight inconsistent errors to severe distortions, omissions, and substitutions. He further states that stutterers and those with voice problems also made errors of articulation. (17) In analyzing articulation test results of 124 subjects from the Fort Wayne Indiana State School, Rigrodsky and Steer (12) report that the voiceless (th) in all positions and the (v) in the initial and medial positions represented five of the ten sounds most frequently misarticulated. Again, it might be noted that many of the articulatory findings reported here involve the retarded child in an institutional environment.

Although the presence of communication deficiencies of mentally retarded children is recognized, studies concerned with alleviation of the problems show diverse viewpoints on the feasibility of therapeutic programs. Brown (5) states: "If the intelligence is low, the chances for improvement are as poor as the chances for improvement of other

functions. A certain amount of progress may occur; the speech may even become almost normal in amount and may be fairly understandable. But usually the child with a serious mental deficiency makes little progress." Stinchfield (1) implies a similar view: "--- speech involves functions which are basic to, although not directly measured by, the intelligence tests. Normal speech, therefore, depends upon intelligence." Van Riper (20) favors speech therapy with the retarded: "... children of low intelligence are generally helped with special techniques known to the teacher of the subnormal children. These children need speech training even more, perhaps, than the usual course of study given them would seem to indicate. Training in the manual and domestic arts should be supplemented by much speech training." West, Ansberry, and Carr (21) outline therapy techniques for use with mentally retarded children and thus appear to agree to a necessity for speech work. Schlanger (16) indicates that speech therapy can bring about improvement in the communication ability of the retardate if the approaches and goals utilized are adjusted to the individual's reduced potential. Mecham (9) using a statistical approach to determine the development and application of procedures for measuring speech improvement in mentally defective children, wrote that "significant improvement as a consequence of speech therapy was indicated by most of the tests; and this improvement was independent of IQ, although the improvement in auditory discrimination wasn't independent of C.A."

The preceding quotations would seem to indicate either a positive or negative view toward speech therapy with retarded children, but

several investigators express a need for more information. Matthews (19) says: "There is no research evidence to show the inability of the mentally retarded to profit from speech therapy. We have learned that the normal child can benefit from many of the techniques which were originally developed many years ago for teaching the exceptional child. It is equally possible that research in the area of speech development and correction in the mentally retarded will make valuable contributions to our knowledge of normal speech development and to the field of speech pathology in general...For the profession of speech pathology we feel an obligation to explore further the field of communication disorders in the mentally retarded." A similar statement was issued by the Subcommittee on Speech and Language Problems Associated with Mental Retardation and Delayed Speech and Language Development (11). "There is very considerable need of basic descriptive research from which further clarification of essential definitions and diagnostic distinctions can be developed."

While the literature cited does provide recognition of widespread language and speech disorders in the mentally retarded population, and many published studies indicate a need for effective habilitative speech programs for the retarded child, the available reports of therapeutic plans are diverse and perhaps do not apply directly to a plan of speech therapy for retardates in public schools. The problem stems not from a lack of interesting experimental programs, but from several other factors: first, the term "mentally retarded child" may refer to a low-level trainable child whose speech functioning is almost a void

or to a high-level educable child whose communicative deficiency may be one or two articulatory errors; another barrier to application of previously attempted programs is that many of the approaches involve institutionalized children where environmental facilities may enhance or distract from the effectiveness of therapy; another factor to be considered is a numerical one, where the institution program is directed toward a smaller group of children, as opposed to the city or county school system where the clinician must plan for a large number of retardates. These factors are not presented as negative aspects of the following brief review of several therapeutic studies, but it should be noted that the relationship of these studies to the present research is quite broad.

Schlanger (15) reported a long-term study with twelve brain-damaged institutionalized children who were mentally retarded and whose speech and language development were severely delayed. Initially, therapy was aimed toward improving awareness, recognition and adjustment to sound and then to speech. Listening training was stressed, with frequent reward. When listening ability and attention span improved, "multi-sensory activites were employed in the attempt to develop a greater verbal output, a more fully developed sentence, more intelligible word production and an improved communication interaction. The ultimate goal was the development of the child's oral communication skills within the framework of his potential."

Low, Lassers and Crerar (8) also developed a speech program aimed toward improvement of communication skills. These authors have used

"Communication Centered Therapy" which emphasizes the five following points:

(1) determining the needs of the group and the needs of individual group members

(2) unifying the group through integrative group activities

(3) arranging activities which evoke communication of the verbal as well as non-verbal level

(4) arranging activities which evoke specific adjustive behavior and specific speech responses

(5) practicing specific speech sounds in context, removing them for isolated sound practice if necessary, but returning them for further practice to the original context

Rigrodsky and Steer (12) applied traditional speech therapy techniques utilizing the auditory stimulus approach and a speech therapy program based on O.H. Mowrer's Autistic Theory of Language Development to 72 institutionalized mentally retarded individuals. The experimental therapy (Autistic Theory) was applied in this manner: "...the children were stimulated with speech sounds and words and were rewarded immediately after the clinician produced the speech signals. The clinician never asked the child to produce the criterion sounds, but if the child responded by making such sounds, his productions were accepted and the subject was praised."

PROCEDURE

The sample involved was drawn from 90 special classes, with a total of approximately 1000 children. The chronological age range was from 6-16 years and the IQ range was 48-78*. Subjects had received recent psychological evaluation utilizing an individual intelligence test. A minimal number of children with subnormal hearing level or gross organic involvement of the oral mechanism were eliminated. A total number of 777 subjects were selected for the study.

Initial classification of the children established two basic groups, the speech-deviant group and the non-speech-deviant group. The classifications were based on results of the Hejna Articulation Test, administered by three speech clinicians. A scale of articulatory severity which has been used by Special District speech clinicians for five years was applied to the speech-deviant group. From the criteria on the scale a rating from (1-least severe) to (5-most severe) is made. The rating is based on number and consistency of articulatory errors and the effect the errors have on communicative ability. This involves a judgment as to easily understood; understood, but problem clearly present; understood with effort; understood by family but not by casual listener; not always understood by family. The severity scale rating for the speech-deviant group was made by one speech clinician. Internal objectivity for the judge was .87 as determined by

*-The scores utilized are in keeping with the special education laws of Missouri.

a comparison of judgments-re-judgments.

Articulation test records were analyzed with regard to type and position of erred sounds. Data were collected concerning (a) phonetic breakdown of errors, e.g., plosives, fricatives, sibilants; (b) total sound errors; and (c) sonat and surd grouping of deviant sounds. Data were collected for both the speech-deviant and the non-speech-deviant groups concerning CA, MA, IQ, and SES (socio-economic-status) for each child.

Phase II concerns the three year program of treatment for the 415 children with speech deviations. The deviant population was divided into three groups defined as (1) experimental, (2) placebo, and (3) control. The children for each group were randomly selected with the following distribution: 140 children in the experimental cell, 145 children in the control cell and 130 children in the placebo cell. The program of treatment for each of the previously mentioned groups was as follows:

Experimental: Children in this group received two half-hour sessions per week of speech therapy. Decision as to whether a child was given individual or group therapy was dependent upon his individual needs and the existence of other children with similar articulatory deviations in his class. Because of the mobility of the sample within the county, each child had some individual and some group therapy. At no time did a group exceed four in number for the experimental subjects. The type of therapy utilized followed the pattern described by Van Riper (20): Initial therapy program contained intensive ear-training exercise

through the techniques of isolation, stimulation, identification and discrimination. Production of new sounds followed the ear training period and the sounds were established by the stimulation method, phonetic placement method, tongue exercise or modification of other sounds. The three clinicians were not given specific, detailed instructions for therapy lesson plans, but were directed to plan a corrective speech program for each child within the framework suggested by Van Riper.

Placebo: Children in this group also received two half-hour sessions per week of speech and language stimulation but they did not receive specific guidance in correcting individual sound errors. The purpose of the placebo segment of the population was to offset the possibility that either positive or negative results of the experimental children's speech work might reflect primarily the special attention or personality factors derived from the therapy situation.

Control: Children in this group received no speech attention of either the experimental or placebo nature. Controls were given articulation tests at the same intervals as the other groups but the testing situation was their only contact with the speech clinicians.

At the end of Phase II, the number of children remaining in each category was as follows: 115 experimentals, 107 controls, and 65 placebos. Various reasons contributed to the reduction of number of subjects. Some children moved with their families from the county to the city or to areas away from St. Louis County. Some children were removed from the educable program and placed in a different

school setting because of results in their periodic clinical re-evaluation. Some of the children were placed in a private speech therapy environment. The final number of 287 children contained within the three divisions represented those subjects who had completed three years in the research program.

Three speech clinicians worked with the experimental and placebo subjects. The caseload was approximately 55-60 children for the clinician each year. During each school year of the three-year research period, the clinicians were assigned to a different area of the county than the area they had serviced in the previous year. In this way, an attempt was made to expose each child to the method of work of all the clinicians. A negligible number of children worked with only two of the clinicians due to re-location of the families or of the special classrooms in which the children were enrolled.

The Henja articulation picture test was administered to each child once each year, usually during the final month of the school year. Absentees were recorded during the summer vacation or during the initial days of the following school year. The results were recorded on a Crown full track tape recorder, Model 801. The microphone used was an AKG D-24, with a mylar-base tape. These instruments were chosen because of their precise sensitivity which would allow a highly accurate recording of speech sounds. During the summer months, the initial tape recordings were edited to eliminate extraneous environmental sounds and to include adequate regular spacing between word productions. Names of the children were replaced

with letter codes and the information was placed on individual identification cards filed in the Central Office.

At the end of the research period, the recordings of each child were removed from the edited tapes and dubbed onto a master mylar-base type of tape. Transfer of recordings took place from an Ampex full track recorder, PR 10, onto the Crown full track recorder, Model 801. The three recordings of each child (1962-63-64) were coded and mixed in such a way that when judgment of the tapes took place later, the listener would be unaware of (1) the type of treatment the child had, i.e., experimental, control or placebo and (2) the sequence of the tests, i.e., 62-63-64 or 62-64-63, etc. The final number of master tapes was 114. These tapes included three articulation tests on each of the following subjects:

Experimental	Control	Placebo	
F 43	F 44	F 26	
M 72	M 63	M 39	
115	107	65	T 287

A single trained listener made judgments on the articulation tests recorded on the 114 composite tapes. Prior to the actual judgment of the tapes, a training session was conducted in which the listener listened to two hours of tapes per day for three days in conjunction with the project director. The listener was instructed to make the following notations on the record blank:

If the sound is omitted, mark "o" .

If the sound is distorted, mark "d".

If the sound is substituted, mark "s" and if the substituted sound is definite, mark it above the "s".

The listener was instructed to stop the tape whenever necessary to re-play any portion in which there was question as to the type of error or the existence of an error. At the termination of the one week training period, the listener and the project director listened independently to a series of 7 tapes. Reliability co-efficients were computed on the basis of number of sounds in error per tape with a resulting score of .84. Reliability was also established on type of error with a resulting score of .74. During the two-month period that the trained listener recorded the results of the tape recordings, randomly selected tapes were re-introduced and a reliability co-efficient was established regarding both the type and consistency of error selection and the number of errors. In the case of number consistency the result was .87, by type of error, .82. The tapes were played back on a Magnecorder PT 6-J through a Scott S-3 speaker system. Listening sessions were limited to one hour and forty-five minutes in length, not exceeding two listening sessions per day. As the listener would judge the set of three recordings for each child, she would mark the speech test record blanks as year A, B and C. A research assistant later matched the listener's results to the pre-recorded code and arranged the test blanks into the logical order of 1962-63-64. The articulation information then derived from the correctly arranged tests was added to the card of general information previously assembled about each child.

RESULTS

Analysis of the information obtained in the articulation testing allowed for the division of the sample into speech-deviant and non-speech deviant groups. See Table I. Reference to Table 1 indicates that 415 children, or 53.41 percent of the 777 subjects, are speech-deviants with a non-speech-deviant group of 362 children or 46.58 per cent of the sample. The median CA of the deviant group was 10.6 years and the median CA of the non-speech-deviant group was 12.5 years. The median MA of the speech-deviant group was 6.8 years and the median MA of the non-speech-deviant group was 8.5 years. The total number of males was 461, with 251 speech-deviants and 210 normals. The total number of females was 316, with 164 speech-deviants and 152 normals.

A major concern of this study was to establish any significant differences between and within groups, considering the variables of sex, CA, MA, and IQ. See Table 2. The .01 level of significance was reached in the following areas: 1) with CA between male speech defectives and male non-speech-defectives, and the total sample of the speech defective group vs. non-speech-defective group; 2) with MA, the categories of male speech defective vs. male non-speech-defective, female speech defective vs. female non-speech-defective, and total group speech defective vs. non-speech-defective; 3) with IQ, between females and the total group; 4) with sex, when IQ was the variable, a significant difference existed between male speech-defectives and female speech-defectives. Significance was not reached with sex as constant and variables of MA and CA.

Also, we have been clinically concerned with the rather wide spread contention that severity of speech defect and IQ are intrinsically related, i.e., the lower the IQ the more severe the articulation problem. We approached this aspect of articulation behavior by relating MA to severity, CA to severity, and IQ to severity. At the .01 level IQ was not a significant measure of the severity of the child's articulation problem but MA and CA were both significant.

More specific analysis of the articulatory ability of the speech deviant children shows several trends in speech behavior. Considering the type of error (substitution, omission, or distortion) by MA, reference to Table 3 indicates that both substitutions and omissions tend to decrease as MA increases. Slightly more errors of substitution occur than errors of omission. Distortion errors increase as MA increases. For example, a male child between 9 and 11 years may have two omissions and three substitutions, but will have 6 errors of distortion.

Table 4 deals with the position of erred sounds. There is a trend for the number of deviant sounds to decrease as MA increases. The incidence of erred sounds seems consistent in all the positions (initial, medial, and final).

Considering phonetic categories of the sound tested with MA as the variable, errors on nasal sounds appear least frequently and errors on sibilant and blend sounds occur most frequently. Working down the scale from more errors to fewer errors, would be affricates, fricatives, glides and plosives. In all areas except sibilant sounds, there is

a substantial decrease in the number of errors as MA increases. The sibilant sounds, however, appear to give as much difficulty to the child of MA of 7 as to the child of MA of 12. See Table 5.

Table 6 indicates that the number of total sound errors exhibited by the children tends to decrease as IQ increases. The average child between 48-75 IQ makes 15 errors and the average child between 68-78 IQ makes 11 errors. With regard to the factor of MA, a child in the 3.0-5.5 grouping makes approximately 17 errors and the child approaching the 12 year MA level errs on only 9 sounds.

Voiced and unvoiced sound errors, when considered in regard to MA or CA, both tend to decrease as age increases. More unvoiced sounds were deviant than voiced sounds.

The primary goal was to establish a pattern of articulatory development for the educable mentally retarded child. Through past experience, we know the value of developmental scales such as those of Templin (18) and Poole (10) and the recent Healey-Hall (3) study. These scales have given clinicians a basis for diagnostic and therapeutic planning for the child of normal intelligence. The speech development of retarded children, however, has not been clearly defined and charted. It has been contended that the retarded child has articulatory development similar to that of the normally intelligent child, if the MA of the retarded is considered rather than his CA. For example, we know that the normal child perfects his articulation skills between the ages of 3 and 7½ years. Does the retarded child make this same articulatory gain between his 3rd and 8th years,

if we use MA rather than CA as a measurement? Our initial assumption was that a chart of articulatory development by MA levels of retarded children would yield a similar developmental period when all consonant sounds would be correctly acquired by 90% of the children. Table 7 was plotted from the 4 year MA level to the 9 year MA level. The sample size at the 3 year MA level and at the 10+ MA level was considered to be too small for an effective judgment of articulation ability. The sample of 4-9 MA levels was approximately 700 children, which included all children within previously described limits of age and mental ability. As seen in Table 7, the acquisition of consonant sounds in a sample of retardates does not follow an orderly pattern. Several sibilant, affricative, and fricative sounds are never passed by 90% of the children through the 9 MA level. The development of articulation in the retardate does not parallel articulatory development of normal children, even when matching MA of the retardate against the CA of the normal child.

In the second phase of the study, an initial description of the sample included an investigation of the mean chronological age, mental age and intelligence quotient of each of the three treatment groups. The figures below represent the findings:

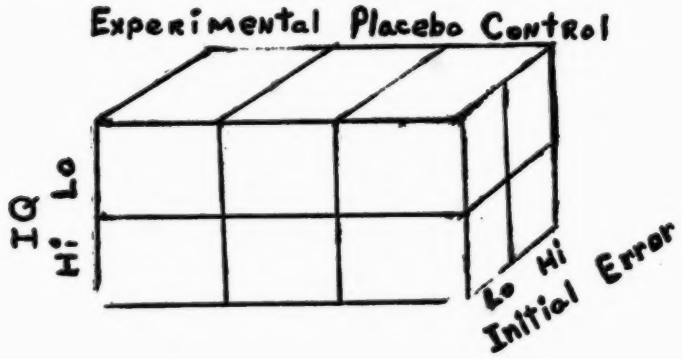
	Experimental	Control	Placebo
CA	9 yrs. 10 mo.	10 yrs. 8 mo.	9 yrs. 4 mo.
MA	6 yrs. 6 mo.	6 yrs. 9 mo.	6 yrs. 3 mo.
IQ	66	67	67
N	115	107	65

The above figures would indicate that the three treatment groups are essentially similar with regard to CA, MA and IQ. As previously indicated in the Procedure section, the sample size in each group is varied due to external factors.

An initial analysis of the data involved a tabulation of the number of sounds in error by year, 62-63-64. A comparison was made between the results of the subjects in each type of treatment. Table 8 represents the mean number of errors of the total sample (male and female) in each group. It can be observed that the change in the experimental group during the three year period was from 18.2 errors in 1962 to 12.3 errors in 1964, with a total reduction of 5.9 errors during the extent of the research period. In the placebo group, number of errors was reduced from 18.2 to 13.6 with total reduction of 4.6 errors. In the control group, the number of errors was reduced from 15.7 to 11.4 with a total reduction of 4.3 errors. Observation of the data would indicate that no marked difference exists between reduction in errors of the three treatment groups over the three year experimental program.

Viewing the general configuration of the data, an attempt at analysis of the information was made which would consider factors such as (1) IQ, i.e., the difference between high and low groups; (2) type of treatment, considering any differences that existed between experimentals, controls, and placebos; and (3) number of initial errors (errors exhibited in 1962) and the effect of this number on the change in articulation behavior throughout the three year period. The desired

information could logically be obtained by consideration of the data in a three dimensional analysis of variance as described by Lindquist (7). The placement of the data was as follows: the treatments (experimental, control and placebo) were considered as columns. IQ was divided into a high group (65-78) and a low group (48-64) and these groups were considered as rows. The initial number of errors was divided into a high group (above 18 errors) and a low group (1 to 17 errors); these two groups were selected within each of the previously described IQ groups so that the four initial error groups were considered as slices. This general pattern might best be visualized in the following three dimensional design:



This design allowed us to ascertain whether a difference existed between treatments, IQ and initial errors and also to determine any interaction between the above factors. Information obtained from his analysis is presented in Table 9. In order to accomplish the three dimensional analysis of variance described by Lindquist, it was necessary to have equal cell size. This equalization of cell size was derived by randomly eliminating the number in each cell to 12, which was the size of the smallest cell.

Table 10 indicates the number of erred sounds which corrected during the three year period, with use of equal cell data.

Observation of the results of the analysis of variance indicates that no significant difference exists between the amount of progress made between the three treatment groups. The F computed between high and low IQ groups did not achieve significance; however, significance at the .01 level was achieved between the high and low error groups. Observation of the figures in Table 9 would indicate that children with high initial errors tended to make significantly greater progress than children with low initial error status. First order effects in the three way analysis indicate no significance between treatment and IQ or treatment and number of initial error; however, between IQ and initial errors, significance was reached at the .05 level.

In visually appraising independent factors which may have some effect on change in articulatory behavior, the first factor considered was sex. Table 11 and 12 indicate the number of sounds in error for the subjects, with male and female division, and separation of types of treatment and years. The total sample of females was 113, distributed in 43 experiments, 44 controls, and 26 placebos. Mean change of error between 1962-64 for the experimentals was 5.6, for controls 3.5, and for placebos 4.8. The total sample of males was 174, distributed in 72 experimentals, 63 controls, and 39 placebos. The mean change of error for experimentals was 6.1, for controls 4.9, and for placebos 4.4. These figures on mean change of error for male and female segments of the sample tend to be compatible with findings for the total sample. The results of the total sample were previously found to be non-significant. (Table 9).

Another dimension which seemed logical to view as to the effect of change on articulatory behavior was that of mental age levels. Refer to Tables 13, 14, 15, 16. The population which ranged in mental age from three years to twelve years according to initial testing date was broken into these four MA groups: (1) 3.0-5.5 (2) 5.6-7.5, (3) 7.6-8.5 and (4) 8.6-12.0. The total N of the 3.0-5.5 MA group was 84, combining male and female of all treatment groups. The distribution was 31 experimentals, 25 controls and 28 placebos. It is notable that improvement in change of errors was made by both the experimental and control groups with no change for the placebo group. The magnitude of change for the experimental group was 8.6, for controls, 7.4.

In the MA group of 5.6-7.5, N was 115, distributed 51 experimentals, 42 controls and 22 placebos. A reduction of errors existed in all three treatments with a change of 6.4 errors for experimentals, 3.7 errors for controls and 3.5 errors for placebos.

At the MA levels 7.6-8.5, N was 45, distributed 17 experimentals, 20 controls and 8 placebos. A positive change occurred in all groups, so that experimentals made 2.8 less errors, controls made 4.0 less errors and placebos made 5.0 leas errors.

In the highest MA levels, 8.6-12.0, the N was 43, with 16 experimentals, 20 controls, and 7 placebos. Again, change occurred in all three groups, with a magnitude of 2.9 for the experimentals, 2.1 for the controls and 1.3 for the placebos. It may be noted that sample size becomes markedly reduced in the upper MA levels, which may be a

contributing factor to the results stated. The preceding information was subjected to t tests to determine whether the difference in sound error reduction between experimental and control groups was significant. Table 17 indicates that no significant difference exists between the two groups.

In the analysis of variance, it became apparent that the main effect dealing with high and low initial errors was significant, therefore necessitating a more comprehensive view of this dimension. In exploring factors which may have contributed to this significance, the three treatment groups were divided into the following mental age categories: (1) 3.0-5.5 (2) 5.6-7.11 and (3) 8.0-12.0. Figure I indicates that in all three treatments there was a decided decline in number of initial errors as the mental age increased and the differences between the groups do not appear to be great. The overall sample with an N of 287 was distributed in this manner. (1) 81 subjects in the 3.0-5.5 level (2) 142 subjects in 5.6-7.11 level and (3) 64 subjects in 8.0-12.0 level. The mean number of sounds in error for these three treatment groups was 24.7 for the youngest MA group, 15.8 for the middle level and 11.2 for the oldest MA level. The central dividing line in Figure I indicates the high and low initial error group. It is evident that those in the high error group are children below the year 5.0 MA level.

Figure II deals with the reduction of errors which took place during the overall experimental period considering the three treatment groups by the same mental age groups as utilized in Figure I. By

combining the entire sample of experimentals, controls and placebos, the mean change in the youngest MA group was 7.4 errors, for the middle group 4.7 errors and for the oldest group 2.6 errors. Figure II further deals with the change in individual treatment groups.

CONCLUSIONS

The first phase of the present study was directed toward an intensive description of the articulation of educable mentally retarded children between the ages of six and sixteen years, IQ 48-78. The sample was drawn from ninety special classes within St. Louis County, each class directly involved in the structure of the Special District of Education for the Education and Training of Handicapped Children. A total sample of 777 children was drawn for the study, with 415 speech defective children and 362 non-speech defective children. The children ranged in MA from three to twelve years. The articulation of each child was tested with the Hejna Articulation Test. A second judgment of the children's communicative ability was made through a rating of the overall intelligibility of speech, using a five-point scale developed in Special District. Approximately 1000 children were tested initially and the final research sample of 777 was derived after elimination of the subjects with hearing disabilities, severe organic problems and lack of recent intellectual assessments. Based on the results of the Hejna test, the incidence of articulation deviations in the sample was found to be 53.41 percent, and 46.58 percent of the sample had normal speech. Of the number of children with speech deviations, 251 were male and 164 were female. In the group of children with no speech defects, 210 were male and 152 were female.

Tests of significance were computed to determine if a relationship existed between severity of articulation and the CA, MA and IQ of the children. The factor of IQ was not significant at the .01

percent level; however, both CA and MA had a significant relationship to severity. An analysis of the type of articulation errors was completed and the results indicated that substitution and omission errors tended to decrease with increasing mental age. The distortion type of error, however, appears to increase as the mental age increases. Further analysis was used to clarify the position of the erred sounds in words to determine whether deviant sounds occurred more often in a particular position. The incidence of deviant sounds was found to be consistent in all the positions (initial, medial and final) and again the tendency existed for the number of errors in each position to decrease with increasing mental age. A reduction in the total number of deviant sounds was observable as the IQ or MA of the sample increased.

Median tests were applied to test the significance of the difference between the speech deviant and the non speech deviant groups with regard to CA, MA and IQ. Results of these tests indicated that differences do exist at the .01 percent level in all three areas. An analysis of the differences between male and female samples was attempted. No differences existed in the areas of MA and CA, but significance was reached when the IQ factor alone was used.

A primary concern in the initial phase of the study was to analyze the development of speech sounds in a large sample of mildly retarded children. In order to establish a developmental sequence of sound acquisition, a phonetic analysis of the articulation test results was compiled. A developmental table that indicated the MA at which 90 percent of the children produced correctly a given sound was plotted.

In reviewing the pattern of development as charted by MA rather than CA levels, it was noted that articulation maturity of this group is not particularly related or parallel to the acquisition of speech as seen in normally intelligent children. The hypothesis that the development of speech by MA levels of the retardates would closely align with the development of sounds by CA of normal children was refuted. While no attempt was made to compare directly the speech of this group of educable retarded children with a population of normally intelligent children, it would appear that sound development differs greatly between two such populations. Of particular interest in the results of the developmental pattern were the sounds that remained deviant in excess of ten percent of the population at the 10 year MA level.

The results of Phase I support the hypothesis that the severity of articulatory deviations is a function of mental age as well as chronological age. An increase in either the mental or chronological functioning of the retardate results in a change in the existence and pattern of articulatory errors. The articulation of the lower MA group is most frequently characterized by omissions and the higher MA group is most frequently characterized by distortions. This pattern of articulation error progression tends to coincide with the nature of errors found in populations of children with normal intelligence. Also notable was the tendency for the non speech deviant group to be significantly more mature in the measured areas of CA, MA and IQ. Observation of the developmental articulation scale plotted for

children between MA levels of four to nine years indicates that sound acquisition in mentally retarded children varies considerably from sound acquisition in a normal population. Expansion of MA levels will be necessary before any definitive conclusions can be reached concerning articulation maturation in the educable retarded child.

A review of the data in Phase II would indicate that speech therapy as provided in this study had no more significant effect on sound error reduction than maturation. It is noteworthy that in the varying considerations of sound error reduction, male vs. female, high IQ vs. low IQ etc., the experimental group made the largest gain in correction of erred sounds, but at no time was the difference between the experimental group and the control or placebo group statistically significant. While the consistent therapy directed toward correction of articulatory deviations did contribute to some gain in articulatory skill by the experimental group, the placebo group also reduced sound errors with generalized language stimulation and the controls made improvement with no instruction. In the analysis of variance, significant difference did exist between the reduction of deviant sounds when the sample was divided between high and low number of initial errors. This difference would seem logical for two reasons: (1) The low initial error group (those with 1-17 errors when tested in 1962) had greater limitations as far as sounds to correct. (2) The low initial error group tended to be the low mental age group and the three year span involved in the duration of the study would contribute significantly to the improvement in speech behavior.

Comparison of the change in the number of erred sounds by sex indicated that the experimental group of both male and female samples made the most notable improvement, with 6.1 for the males and 5.6 for the females. The control group results indicate a change of 4.9 for the males and 3.5 for the females. In the placebo group, the males reduced the number of errors by 4.4 sounds, and the females 4.8. Throughout the experimental period, little difference was observed between the performance of male and female in any of the treatment groups. While both the males and the females of the experimental group made more gain in correction of errors than did either the males or females of the placebo or control groups, the change was statistically non-significant. The data involved in the area of sex and reduction of errors was subjected to tests of significance, but the resultant findings were less than significant. Additional viewing of the data by sub-categories of mental age also failed to yield significant differences.

IMPLICATIONS:

Information derived from the initial phase of the study substantiates the presence of widespread articulatory errors in the educable mentally retarded group. It is also clear that this high incidence of speech deviations is closely related to a mental age factor. In the sample of 777 children studied, the MA group from 3.0-5.5 exhibited the highest incidence of speech deviations and the most severe type of deviations. An analysis of the type of articulatory errors indicates omissions to be most frequent in the lowest MA group and distortions to be more prevalent with the higher MA levels. This particular finding tends to parallel the articulatory behavior of the population with normal intelligence.

It was noteworthy that of the sample studied, children who had articulatory deviations (speech defective population-Phase I) had a significantly lower MA as well as CA. Observation of the IQ of these two groups (speech defective and non speech defective) yielded no significant difference. These findings would tend to support the hypothesis that the presence of deviant articulation is related to the mental age of the retarded child. From the clinical point of view, this becomes important in the selection of cases for the administration of speech therapy, particularly if the assumption is made that speech therapy is not specifically a device for expediting maturation. The clinician who is faced with the responsibility of selecting a limited number of cases from a larger group of mildly retarded children may well benefit by first considering the MA of the child. The IQ appears to be of less importance in that incidence and severity of errors, as

well as gain in the correction of deviant sounds appear to be more closely related to the MA factor.

The analysis of articulatory functioning in the mentally retarded child with regard to sound development indicates a definite need for extensive investigation which will yield more stable figures for comparison of articulation in the retarded versus the normal population. The limited information obtained with this sample would tend to refute any concept that speech development in the retarded population is similar to that of a population with normal intelligence, even when the retarded group is viewed by MA rather than CA. It would appear feasible to find substantial differences in speech development of retarded and normal groups if sound acquisition was charted by chronological levels, but the continuation of these differences when using the MA of the retardates implicates a unique pattern for the retarded population. Again, an extension of the knowledge about the sound development of the retarded child would tend to improve and refine the selection of cases for therapy. Considering first the MA of the child, the clinician would further benefit by the opportunity to compare the child's articulatory ability to a standardized scale of articulatory ability of retarded children. This kind of comparison would seem to be more meaningful than judging the speech of the retardate by the speech of his chronological peers. The interpretation of speech test results to school personnel and parents would also become a more logical task in that the articulation of the retarded

child would be reviewed within the actual scope of his intellectual limitations rather than attempting to adjust or modify the results to fit within a framework of normal children's speech ability.

Throughout the present study, no attempt was made to correlate the etiology of mental retardation of the children to their speech behavior. Early in the study, an attempt was made to classify the socio-economic status of each child according to father occupation. A lack of pertinent or accurate information for many of the families involved in the study did not permit statistical presentation of this data; however, the available information was processed for an informal interpretation and results indicated that a negative correlation exists between the socio-economic level of the family and the incidence and severity of articulatory deviation.

The tendency noted here would lead to a recommendation for a more extensive attempt to systematically divide the retarded population by etiology and the subsequent study of articulatory development by retardation etiology would be an important addition to the knowledge of communicative deviations.

In Phase II, the general conclusion reached in this study was that the gross approach to speech therapy common to a public school setting is of little value. By gross approach is meant a somewhat random selection of cases with subsequent administration of two half-hours of therapy per week. The initial selection of experimental cases for the study was similar to the manner of selection in a public school setting with normally intelligent children. All of the educable children were screened informally, with an articulation

evaluation following for those who produced error sounds in screening. After the testing period, a reasonable case load was derived which included both males and females, severe and mild speech problems, and an opportunity for both individual and group treatments. As indicated through-out the results of the second phase, however, this approach to selection of cases and administration of therapy did not provide significant gains in articulatory ability to the experimental group. It was noteworthy that the average improvement made by the experimental group tended to be consistently greater than that made by either the placebo or control group although the difference was non-significant. There may be an indication that a more definitive approach which includes more specific selection of cases and more intensive therapy would yield a difference that would be statistically significant.

The present study has established the primary information that (1) there is a high incidence of articulatory deviation in an educable mentally retarded population and the incidence and degree of severity is closely related to mental age levels and that (2) the application of direct articulation therapy as described in this study does not significantly alter the number of error sounds produced by the children in the experimental treatment group.

Extended investigation is suggested in the areas of a definitive speech development scale of educable retarded children, in precise method of selection of potential therapy cases considering MA and etiological factors, and in development of a more intensive therapy program when it is indicated.

APPENDIX

Table I. Incidence of speech deviant and non-speech-deviant children in the educable mentally retarded sample.

	Number of Children	Male-Female		Percentage of total sample	Median CA	Median MA	Median IQ
Speech-deviant	415	251	164	53.41	10.6*	6.8*	63*
Non-Speech-deviant	362	210	152	46.59	12.5*	8.5*	68*
Total Sample	777	461	316				
*Difference Significance	.01						

Table 2. Median differences between speech-deviant and non-speech-deviant samples.

	Samples compared	Median test value
C.A.	Male speech-deviant vs. male non-speech-deviant	31.49*
	Female speech-deviant vs. female non-speech-deviant	6.14
	Total speech-deviant vs. total non-speech-deviant	34.78*
M.A.	Male speech-deviant vs. male non-speech-deviant	42.86*
	Female speech-deviant vs. female non-speech-deviant	20.28*
	Total speech-deviant vs. total non-speech-deviant	58.14*
I.Q.	Male speech-deviant vs. male non-speech-deviant	5.91
	Female speech-deviant vs. female non-speech-deviant	24.87*
	Total speech-deviant vs. total non-speech-deviant	17.40*

*Significant at .01 level

Table 3. Average number of deviations by type of error.

M.A.	Substitutions		Omissions		Distortions	
	M	F	M	F	M	F
3.0-5.5	9.29	8.84	6.93	7.06	3.94	3.99
5.6-8.5	5.68	5.24	3.31	4.39	3.85	5.16
8.5-12.0	3.32	2.80	1.77	1.45	5.66	5.60

Table 4. Average number of deviations by position of error.

M.A. Level	Initial		Medial		Final	
	M	F	M	F	M	F
3.0-5.5	6.45	5.65	6.93	6.84	6.79	6.90
5.6-8.5	3.50	4.23	4.50	5.20	4.67	5.39
8.6-12.0	3.39	2.82	3.71	3.37	3.75	3.57

Table 5. Mean percentage of errors according to phonetic category tested.

Category tested	Mental Age 3.0-5.5	5.6-8.5	8.5-12.0
Sibilants	43.51	30.17	31.15
Affricates	33.98	23.12	22.39
Fricatives	32.75	18.74	9.90
Glides	23.28	12.91	8.85
Plosives	10.33	5.03	2.31
Nasals	6.38	2.20	.49
(Blends)	50.28	28.03	20.74

Table 6. Average number of total sound errors by M.A. and I.Q. Male plus female.

M.A.	Average number of errors	I.Q.	Average number of errors
3.0-5.5	17.28	48 - 58	15.93
5.6-8.5	12.10	50 - 68	12.32
8.6-12.0	9.57	69 - 78	11.49

Table 7.

SOUND DEVELOPMENT CHART
(M.A. AT WHICH NINETY PERCENT OF CHILDREN PRODUCED SOUND CORRECTLY)

MALE

Position of sound	MA 4	MA 5	MA 6	MA 7	MA 8	MA 9	Not passed
INITIAL	m n p h b k t w	g f		y l		r v (th) j	sh ch s z th
MEDIAL	m n p h w b	g f t d	d ng k	v	y l	j r	sh ch (th) s z th
FINAL	m n	p k	b f d ng	g t	l	v j r	sh ch (th) s z

FEMALE

INITIAL	m n p h w b k g f d t		y l	v j sh			r (th) ch th s z
MEDIAL	m h b f ng d	m p w t	k g y	l v j			r sh ch (th) s z th
FINAL		m n p b d	k ng	f g	l t	v	r sh ch (th) j s z

TOTAL

INITIAL	m n p h w		g y	l j		v (th)	r sh ch s z th
MEDIAL	m n h w b	p f d t	k g ng y	l v j		th r	sh ch (th) s z
FINAL	n	m p b d	f ng	k g t	l		r sh ch v (th) j s z

Table 8. Mean number of sound errors by year and type of treatment

	Experimental	Placebo	Control
62	18.2	18.2	15.7
63	14.8	16.8	14.2
64	12.3	13.6	11.4
Change	5.9	4.6	4.3
N	115	65	107

Table 9. Source of variance and F ratios.

Source	SS	df	ms	F
A (IQ)	85.6	1	85.6	2.25
B (Treatment)	61.9	2	30.9	.811
C (Initial errors)	1620.0	1	1620.0	45.52**
AB	7.8	2	3.9	.010
AC	166.8	1	166.8	4.38*
BC	98.8	2	49.4	1.30
ABC	25.1	2	12.5	.328
WC	4578.0	120	38.1	
Total	6644.0	131		

*sig. at .05
**sig. at .01

Table 10. Change in number of sounds in error based on analysis of recordings 1962-64

		Treatment Type									
		Experimental B[1]				Control B[2]				Placebo B[3]	
IQ 66 - 78	Initial Errors 18+ C[1]	17	5			9	7			10	19
		9	16			15	21			-2	7
		16	16	Sx^2	3259	24	9	Sx^2	2295	16	15	Sx^2	7797
		11	23	Sx	163	15	-1	Sx	147	20	-7	Sx	111
		27	14			8	16			15	3		
		20	-11			14	10			7	8		
	1 - 17 C[2]	0	2			8	4			2	1		
		5	6			-2	8			3	5		
		2	8	Sx^2	316	5	2	Sx^2	312	5	6	Sx^2	188
		-1	-12	Sx	20	-1	7	Sx	42	-1	5	Sx	40
		0	2			-2	8			1	4		
		3	5			1	4			6	3		
I Q 48 - 65	Initial Errors 18+ C[1]	10	7			4	19			3	2		
		16	12			3	7			13	11		
		20	12	Sx^2	1573	9	8	Sx^2	1191	9	7	Sx^2	924
		3	-5	Sx	111	-1	3	Sx	99	-5	19	Sx	78
		3	7			14	12			6	4		
		8	18			6	15			2	7		
	1 - 17 C[2]	6	12			6	8			-2	1		
		9	1			5	4			8	2		
		7	-3	Sx^2	419	2	2	Sx	224	3	5	S	223
		-4	5	S	47	6	-1	Sx	38	1	4	S	39
		5	4			5	3			3	5		
		1	4			-2	0			1	8		

Table 11. Average number of sounds in error for the female population.

	Experimental		Control		Placebo	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
1964	11.7	11.66	10.3	9.25	10.4	12.14
1963	14.0	13.74	13.5	10.31	13.3	12.96
1962	17.3	16.39	13.8	11.65	15.2	13.88
N	43		44		26	t - 113

Table 12. Average number of sounds in error for the male population.

	Experimental		Control		Placebo	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
1964	12.6	13.34	12.2	13.42	15.8	13.43
1963	15.2	14.13	14.7	14.07	19.1	16.05
1962	18.7	14.85	17.1	14.80	20.2	14.88
N	72		63		39	t = 174

Table 13. Average number of sounds in error for the MA 3.0-5.5 population.

	Experimental		Control		Placebo	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
1964	18.3	17.45	15.6	15.63	22.7	14.14
1963	21.7	18.08	19.2	14.55	22.5	14.96
1962	26.9	18.78	23.0	15.99	22.6	13.52
N	31		25		28	t = 84

Table 14. Average number of sounds in error for the MA 5.6-7.5 population

	Experimental		Control		Placebo	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
1964	10.6	9.32	10.4	7.87	13.0	13.68
1963	14.0	11.82	11.9	10.37	15.0	15.75
1962	17.0	13.15	14.1	11.05	16.5	15.14
N	51		42		22	t = 174

Table 15. Average number of sounds in error for the MA 7.6-8.5 population.

	Experimental		Control		Placebo	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
1964	11.9	12.52	10.6	11.01	14.0	15.91
1963	12.1	10.34	12.3	12.32	18.6	14.34
1962	14.7	12.92	14.6	13.20	19.0	16.76
N	17		20		8	t = 45

Table 16. Average number of sounds in error for the MA 8.6-12.0 population.

	Experimental		Control		Placebo	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
1964	6.6	6.89	9.3	13.86	3.7	3.49
1963	6.3	7.60	10.0	12.96	3.4	3.59
1962	9.5	9.00	11.4	13.36	5.0	3.69
N	16		20		7	t = 43

Table 17. Comparison of MA to erred sound reduction between experimental and control groups between initial and final testing.

	Experimental	Control	Change	t
MA 3.0-5.5	8.61	7.04	1.57	.579
MA 5.6-7.5	6.31	3.76	2.55	1.38
MA 7.6-8.5	3.75	2.76	.99	.489
MA 8.6-12.0	2.94	2.24	.70	.384

Figure I. Consideration of initial errors by MA groups.

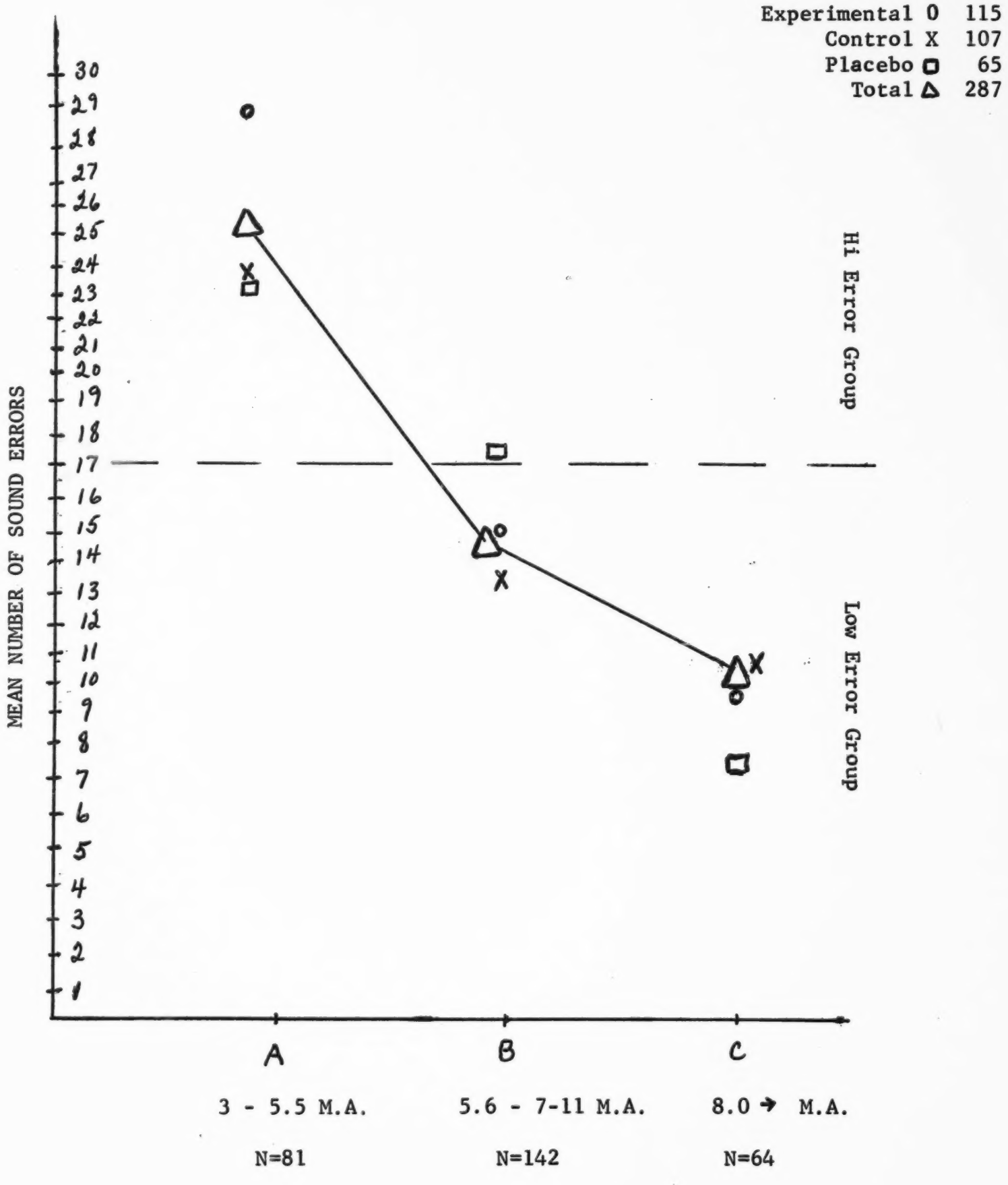
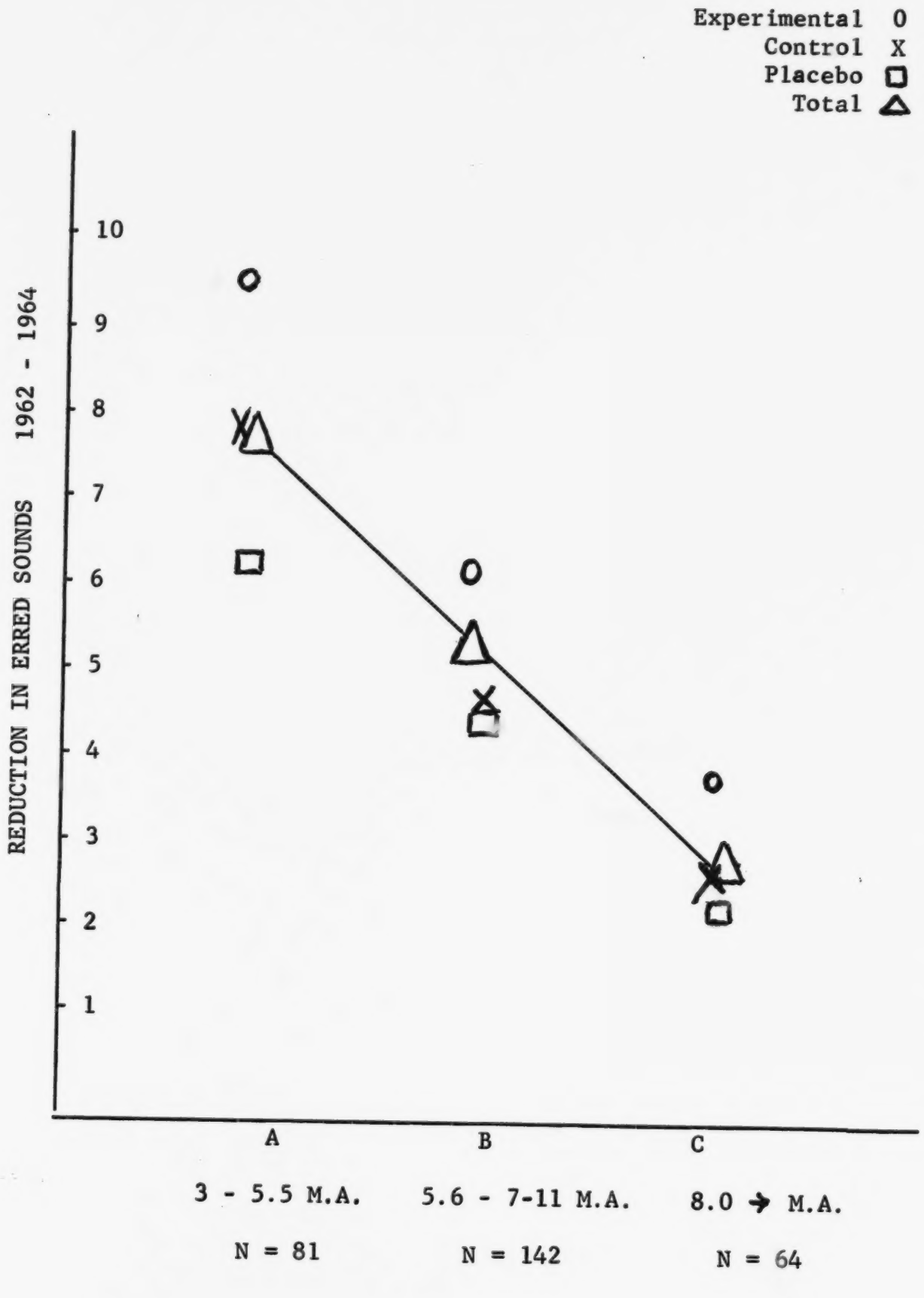


Figure II. Reduction in number of erred sounds by MA groups.



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